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ABSTRACT

Ten learning stations containing displays and student activities relating to energy comprise the seminar described in this booklet. On a data sheet, each student answered questions based upon information obtained at the learning stations. The guide contains instructions for constructing each exhibit, including a materials list, estimated cost, and a photograph of the completed station. Also provided are an energy quiz and sample student data sheet. Although the seminar was designed for junior high school participants, it has been used successfully with students in fifth grade through senior high. Among the topics investigated are insulation types, thermostat setting, chemically-produced electricity, energy efficiency, and electricity from mechanical energy. (WB)

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# INTRODUCTION

The energy activities described in this booklet have been designed and prepared by the staff of Quarry Hill Nature Center, Rochester, MN. Since their construction in 1975, the learning activities have been used by over 10,000 participants. They have been distributed to area schools with the support of the Regional Environmental Education Council.

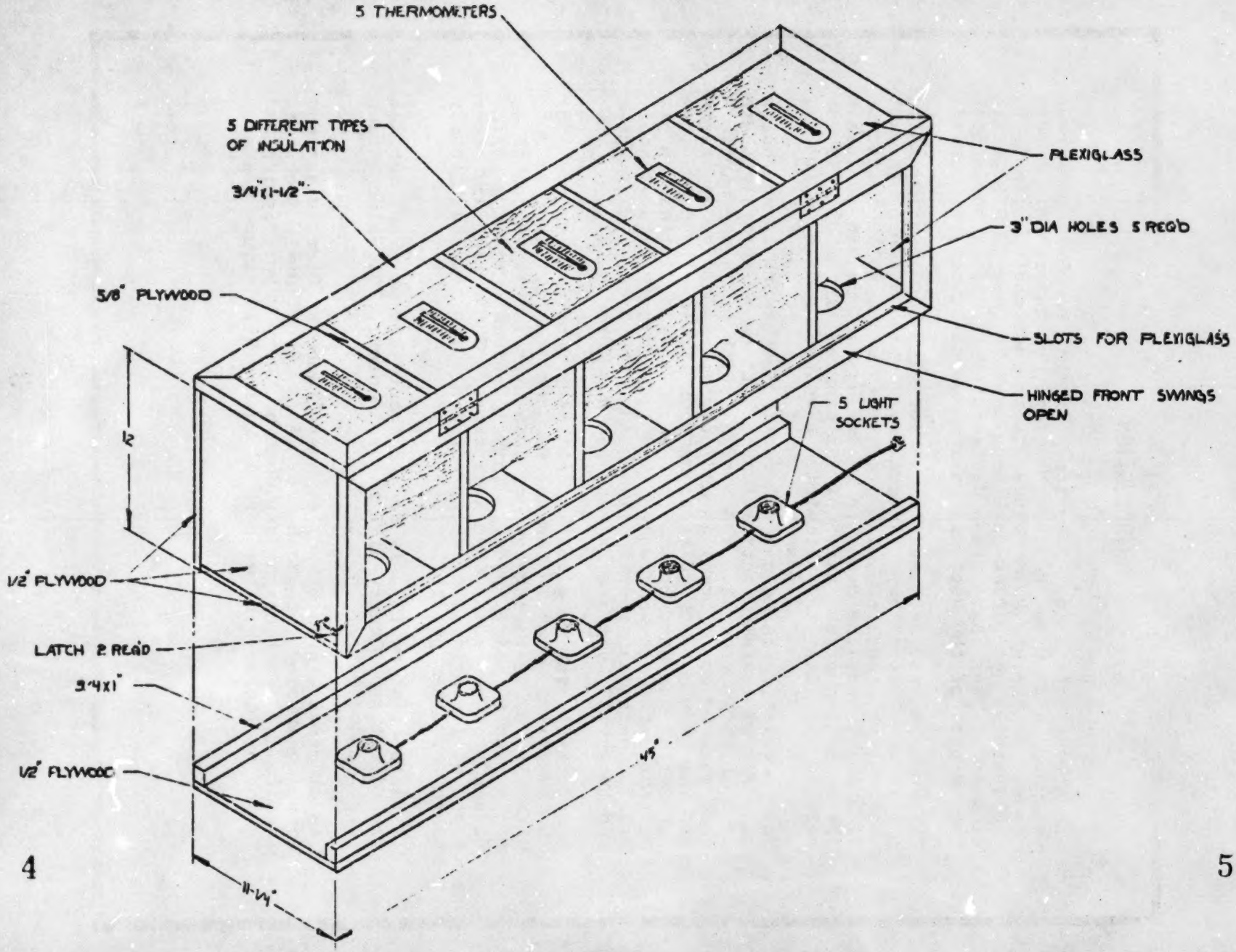
This program was designed for junior high aged participants, but it has been used successfully from Grade 5 through senior high students. The program is meant to be a discussion initiator; the means to an end and not an end in itself. The most important part of the program is the followup carried out after the activities have been completed.

This booklet contains the information necessary to reproduce this set of learning activities. With each activity there is a physical apparatus and a sign which tells the participant what to do. Drawings and/or pictures of the apparatus and the text of the directions sign are included in this booklet. The description for each activity includes hints on constructions and where supplies might be available. Printed materials are also included. The Student Data Sheet and Energy IQ Quiz are in reproducible form.

A materials list is given as well as an approximate cost for the activity. The lettering for these activities was done with a LeRoy lettering device, using the templates requiring the #8 and #5 size pens. This provides printing large enough to be read from a distance. There are many other types of lettering available. Check with the art supply store for other possibilities.

If further information is needed about this program, contact the Director, Quarry Hill Nature Center, 701 Silver Creek Road NE, Rochester, MN 55901.

The diagrams in this booklet were done by Gerri Meyer and John Lodermeier of Rochester Area Vocational Technical Institute. Photography was done by Larry Meyer; typing and layout by Idelle Manthei both of Quarry Hill Nature Center.

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ENERGY ACTIVITY 1 - HOW IS YOUR HOUSE INSULATED?

## ACTIVITY 1 - How Is Your House Insulated (cont'd)

### MATERIALS (for 1 box)

18 sq.ft. 1/2" AD plywood
28 ft. 1 x 2" pine
8 sq.ft. plexiglass
5 procelain light sockets
10 ft. 12-2 wire
1 plug
1 pr. hinge
2 latch hook
5 thermometers
Assorted insulation
5 60-watt light bulbs
5 wire baskets to hold insulation

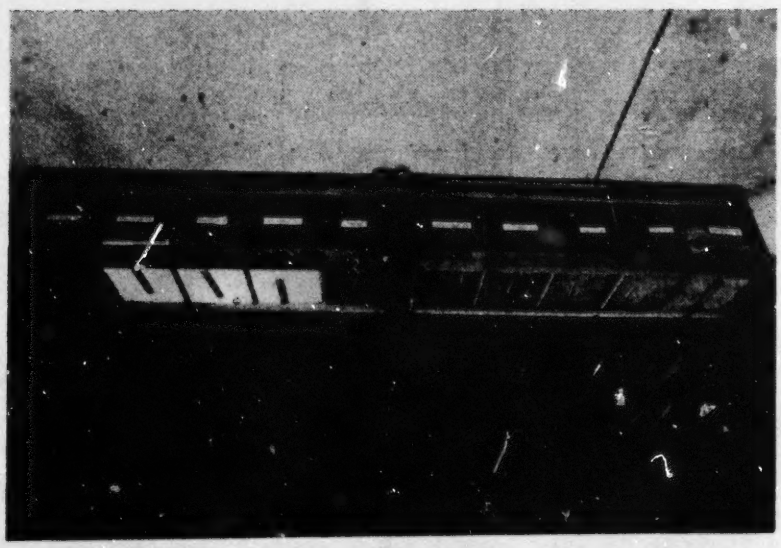
Approximate Cost $52.00

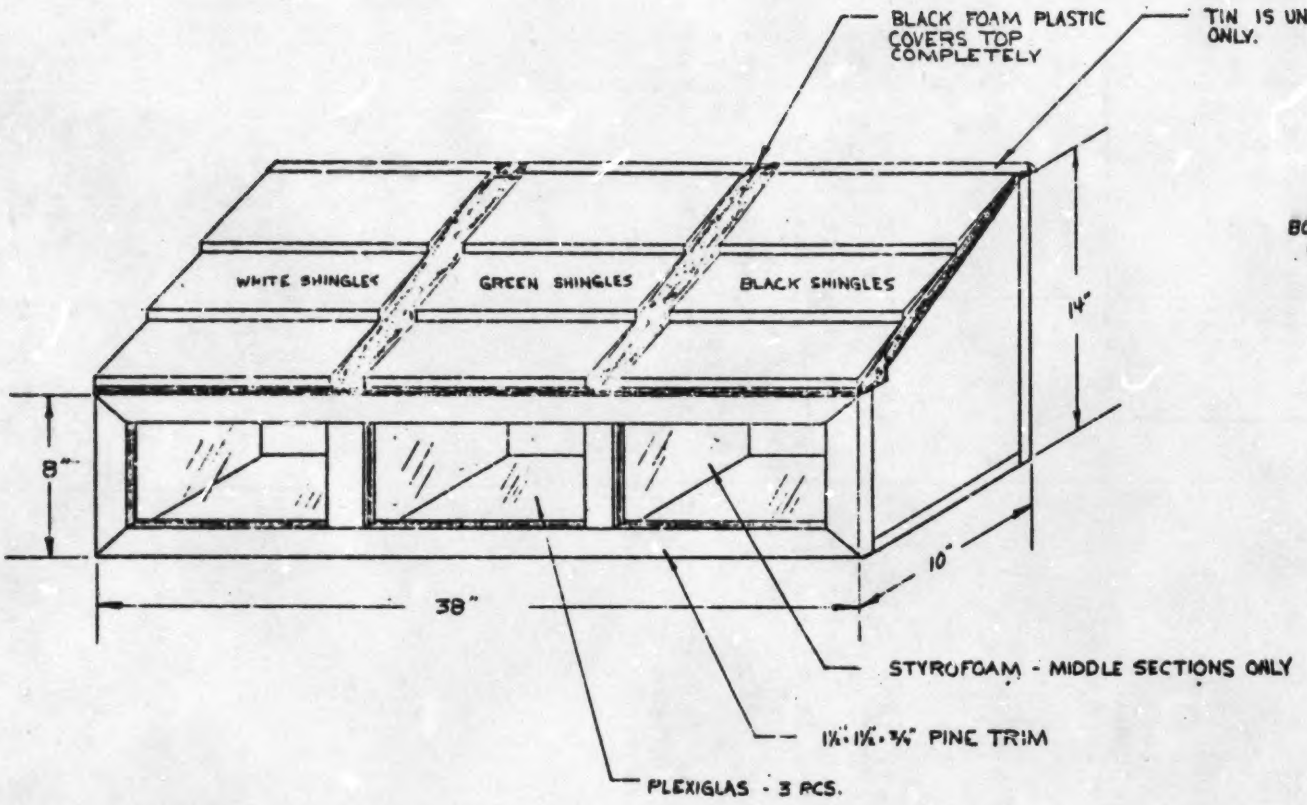
### DIRECTIONS SIGN

*HOW IS YOUR HOUSE INSULATED? Each compartment is insulated with a different thickness or kind of insulation. Read the thermometers in each of these boxes. Put your readings on the Data Sheet. Please try to read the thermometer as accurately as you can.*

### DESCRIPTION

In this activity, participants compare the amount of heat transferred through 9 different kinds/thicknesses of insulation. One compartment has no insulation. Insulations include three thicknesses of styrofoam, two of fiberglass, two of fluff and two of vermiculite. In discussion, the data will be useful for determining which insulation would be best to use for homes. Students will get very interested in what insulation their own homes have and how effective it is. Please note that the materials list is for one box and two are required. They are identical. The insulation is held up by wedging it in place or by placing it in a 1/8" mesh hardware cloth basket which is wedged into the compartment.




BLACK FOAM PLASTIC COVERS TOP COMPLETELY
TIN IS UNDER SHINGLES ONLY.
BOTTOM, SIDES, BACK
½" PLYWOOD
WHITE SHINGLES
GREEN SHINGLES
BLACK SHINGLES
14"
8"
10"
38"
STYROFOAM - MIDDLE SECTIONS ONLY
1¼"·1¼"·¾" PINE TRIM
PLEXIGLAS - 3 PCS.

## ACTIVITY 2 - DON'T BLOW YOUR TOP (CONT'D)

### MATERIALS

9 sq.ft. 1/2" AD plywood
3 sq.ft. 1/8" plexiglass
10' 1 x 1½" pine trim
3 13 x 12" pcs. sheet metal
Asphalt shingles, 1 each of white, green & black
Foam weather stripping
4 sq.ft. 2" styrofoam
Epoxy glue
2 heat lamps/stands
3 thermometers

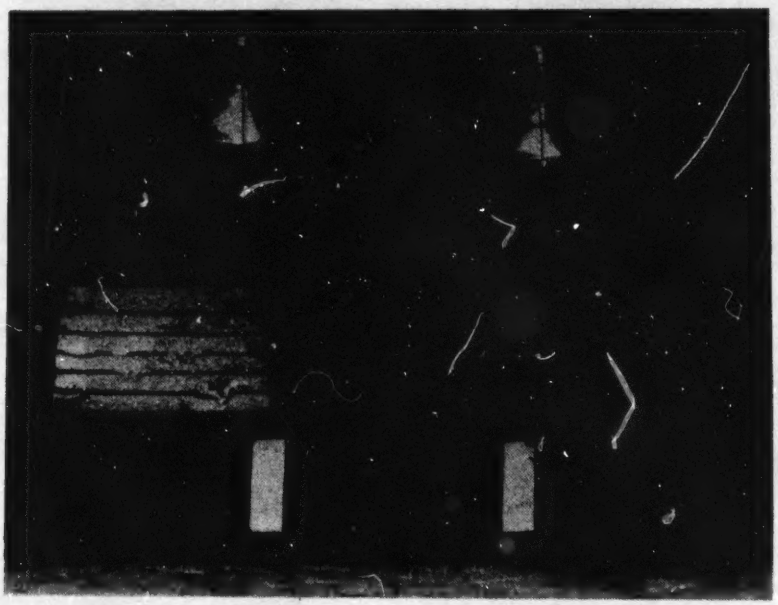
Approximate Cost $41.00

### DIRECTIONS SIGN

*DON'T BLOW YOUR TOP!*
*Does shingle color have an effect on attic temperature? Measure the temperature in each of the compartments. Record the temperatures on your Data Sheet.*

### DESCRIPTION

In a rough sort of way, this demonstrates the effect of shingle color on attic temperature. By placing 2 or 3 heat lamps over the shingles, they will absorb heat at different rates which can be measured by a thermometer. Tape the thermometer to a paper cup with the bulb close to the metal under the shingles. The thermometer can be read through the glass front on the model. For a discussion of what color is best, see Teacher Data. The shingles can be cut in 2" strips and glued on the sheet metal pieces with epoxy. CAUTION: DO NOT ALLOW THE HEAT LAMPS TO BE PLACED CLOSER THAN 14" FROM THE SHINGLES OR THEY WILL MELT!



# ENERGY ACTIVITY 3 - COOL OR WARM

## MATERIALS

1' x 2' 3/4" AD plywood
2 discarded thermostats
Chart showing gas comsumption

Approximate Cost $5.00

## DESCRIPTION

The thermostats should show 7°F difference (72° and 65°). From the chart it would be the same as having a day 7° warmer. The gas savings can be calculated from the chart. The Data Sheet has prescribed steps which will allow further calculations. (See Student Data Sheet, P. 10.) The calculations on the Data Sheet are all based on gas consumption and buildings heated in Rochester, MN, in 1975. Your town and current prices would be most effective. You should be able to gain the necessary information from your gas company.

## DIRECTIONS SIGN

*COOL OR WARM*
*Here are two furnace thermostats. Read the setting on each one and record it. Your Data Sheet has information that will help you calculate the amount of natural gas which would be saved if every home in Yourtown chose the lower setting.*

## ENERGY ACTIVITY 4 - FUELISH FILTERS

### MATERIALS

Assorted letters for signs
2 shoe boxes as fake furnaces

Approximate Cost $0.00

### DIRECTIONS SIGN

*FUELISH FILTERS*
*Here are two furnaces. One has a dirty filter and the other has a clean filter. Read the thermometers in each smoke stack. Record the data.*

### DESCRIPTION

Temperatures were taken in the stacks of 2 furnaces. One furnace had a clean filter and one had a dirty filter. The stack temperatures were 660°F with the dirty filter and 530°F with the clean filter. A shoe box or other suitable "fake furnace" will allow the temperatures to be displayed. The point of the whole thing is to show that when filters are dirty, more heat goes up the chimney than if filters are clean.

## ENERGY ACTIVITY 5 - CHEMICAL ELECTRICITY

### MATERIALS

Auto battery
Dry cell
Hot shot battery
Flashlight cells
Voltmeter
Ammeter

Approximate Cost $30.00

### DIRECTIONS SIGN

*CHEMICAL ELECTRICITY*
*Here is a collection of devices which produce electricity chemically. There are also voltmeters and ammeters which you can use to measure the electricity produced by these batteries and cells. Record your measurements on the Data Sheet.*

### DESCRIPTION

A collection of four or five batteries are used in this activity to demonstrate the amount of electricity produced by each. An auto battery, hot shot (electric fence) battery, dry cell, and two different sizes of flashlight batteries are used. These devices produce electricity chemically. There are voltmeters and ammeters which can be used to measure the amount of electricity produced. Record your measurements on the Data Sheet.

## ENERGY ACTIVITY 6 - MECHANICAL ENERGY

### MATERIALS

2 generators
2 clamps
Wire

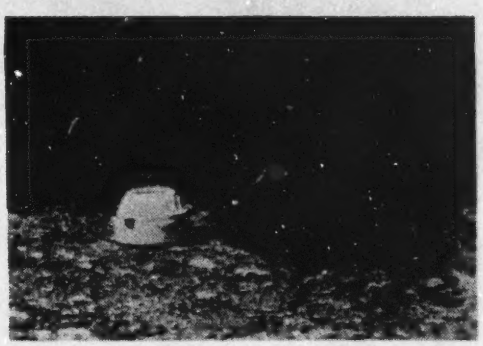
Approximate Cost $42.00

### DESCRIPTION

Small generators like this were used in the old-fashioned wall telephones to ring the bell on a telephone at a second location. This activity will be a popular attraction and will produce loud noises. Students should not be required to "feel" electricity as it affects people in different ways. The clamps can be used to fix the generators to the table.

### DIRECTIONS SIGN

*MECHANICAL ENERGY*
*These are small devices which produce electricity by turning a coil of wire in a magnetic field. One of these will light a small light bulb. The other will give you an opportunity to feel electricity. Have the members of your group hold hands with the first and last persons holding on to the bare wire. Have someone turn the crank. Record your feelings.*



## ENERGY ACTIVITY 7 - HEAT—THE THIEF OF POWER

### MATERIALS

Flow chart of power plants

Approximate Cost $0.00

### DESCRIPTION

The purpose of this activity is to make the student understand that any time heat is used to produce energy there is a greater power loss than if heat is not used. See Teacher and Student Data Sheets. The chart was produced by Northern States Power in 1965. Other similar charts of power production and transmission should be available from your local electric company. After you receive the chart, merely add the percentages from the picture to the appropriate location to modify it for a simple heat-energy loss study.

### DIRECTIONS SIGN

*HEAT—THE THIEF OF POWER*
*As you study this chart, notice that the hydroelectric generating plant loses about 25% of its energy to friction (heat). The numbers on the steam generation plant suggest percentages of energy loss from points. Calculate the total energy loss in the steam generation plant.*

## ACTIVITY 7 - HEAT—THE THIEF OF POWER (CONT'D)

## ENERGY ACTIVITY 8 - LIGHT POWER

**MATERIALS**

Fluorescent light fixture
Incandescent light fixture in wood or metal reflector frame
2 light meters
2 thermometers
Supports

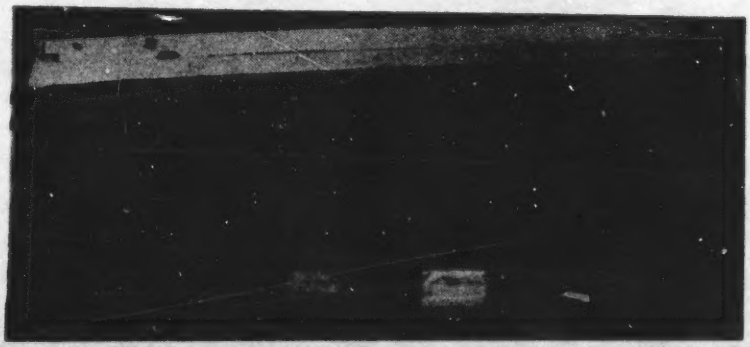
Approximate Cost $95.00

**DIRECTIONS SIGN**

*LIGHT POWER*
*These two boxes contain fluorescent and incandescent light bulbs. They both require the same amount of electricity. Read the thermometer under each box and record the readings on your Data Sheet. Read the light meter under each box and record that data.*

**DESCRIPTION**

This activity is designed to illustrate the difference in efficiency between fluorescent and incandescent lights. Eighty watts are consumed and the fluorescent bulbs produce more light and less heat than the same sized incandescent. This can easily be measured with a light meter and a thermometer. The lights can be hung or supported on ring stands.



## ENERGY ACTIVITY 9 - CLEAN OR DIRTY

### MATERIALS

3 pieces of white cardboard
(8 x 10")
Wood, coal & gas
Clear contact paper
Assorted letters

Approximate Cost $5.00

### DIRECTIONS SIGN

*CLEAN OR DIRTY*
*Here are three examples of pollution collected from burning fuels. Rank them in order from the cleanest to the dirtiest.*

### DESCRIPTION

This activity will show the particles given off by burning three types of fuel. When the fuels are burning, hold the piece of white cardboard over the flame for a specific length of time. When all three fuels have been done, cover each piece of cardboard with clear contact paper to "fix" the particles to the paper.

## ENERGY ACTIVITY 10 - SUNPOWER

### MATERIALS

Fresnel lens
2 beakers
2 thermometers

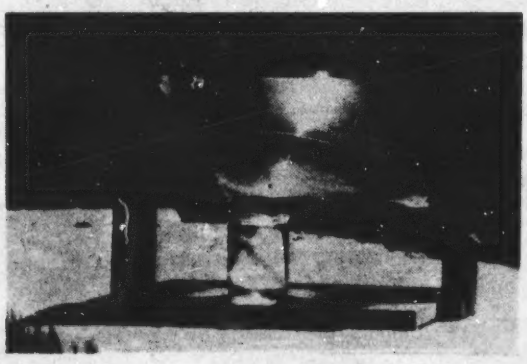
Approximate Cost $18.00

### DIRECTIONS SIGN

*SUNPOWER*
*This device is a Fresnel lens. It focuses the sun's rays to a small area or point. This can be used to heat objects. Some lenses are powerful enough to melt lead. Read the thermometer in each beaker and record the temperature of each. What is the cost for fuel to warm this water?*

### DESCRIPTION

The Fresnel lens focuses sunlight to a small point. If this concentrated light is focused on a beaker of water, it will raise the temperature of the water. By placing two beakers side by side - with one at the focal length of the lens and the other not at the focal length, the difference in temperatures can be measured. The lens is from an overhead projector and can be supported in a variety of ways, one of which is shown in the photograph.



REGIONAL ENVIRONMENTAL EDUCATION BOARD and QUARRY HILL NATURE CENTER

ENERGY SEMINAR
Student Data Sheet

Name _____

PART I HEAT & INSULATION

Activity #1 - How is Your House Insulation

| Compartment Number | Type of Insulation | Thickness | Temperature |
|---|---|---|---|
| 1 | Control | ---- | |
| 2 | Styrofoam | 1/2 in. | |
| 3 | Styrofoam | 1 in. | |
| 4 | Styrofoam | 3 in. | |
| 5 | Fiberglass | 3 in. | |
| 6 | Fiberglass | 6 in. | |
| 7 | Fluff | 1 in. | |
| 8 | Fluff | 3 in. | |
| 9 | Vermiculite | 1 in. | |
| 10 | Vermiculite | 3 in. | |

Activity #2 - Don't Blow Your Top

Temperature under:

A. Green shingles _____$^{o}$
B. White shingles _____$^{o}$
C. Black shingles _____

Activity #3 - Cool or Warm

1. Record the difference between the thermostat settings ($65^{o}$ and $72^{o}$).

_____$^{o}$

2. From the chart find how much gas is used on a $0^{o}$ day in Yourtown.

_____cu.ft.

3. If this amount (31,000,000 cu.ft.) is used when thermostats are set at $72^{o}$, then the setting at $65^{o}$ would use 29,000,000 cu.ft. (This would be the same as a day $7^{o}$ warmer than zero on chart.)

Student Data Sheet 

4. What is the difference in gas use on a $0^{o}$ and a $+7^{o}$ day in Yourtown? (31,000,000 - 29,000,000) _____cu.ft.

5. If there are 16,000 buildings in Yourtown using gas, calculate the savings of gas each building would effect by using the lower thermostat setting. (2,000,000 ÷ 16,000) _____cu.ft.

6. Assuming that gas cost $1.20 per 1,000 cu.ft. or $.0012 per cubic foot, how much money would each building save each day at the lower thermostat setting ($.0012 x 125) _____cents

7. Assuming a 180-day heating season, how much would each building save per year? (.15¢ x 180) $_____

8. If all the buildings in Yourtown used the lower thermostat setting, how much money would be saved in a year? (16,000 x $27.00) $_____

9. What would be the total amount of gas saved in a year? (2,000,000 x 180) _____cu.ft.

Activity #4 - Fuelish Filters

1. Smoke stack temperature of furance with dirty filters _____$^{o}$
2. Smoke stack temperature of furnace with clean filters _____$^{o}$

PART II LIGHT & ELECTRICITY

Activity #5 - Chemical Electricity

Voltage measurements from:

1. Flashlight cell _____
2. Ignition cell _____
3. Multiple ignition cell _____
4. Auto battery _____

Activity #6 - Mechanical Electricity

I think electricity feels like _____

_____.

Activity #7 - Heat - The Thief of Power

1. Power loss from burning fuel _____
2. Power loss from friction of turbine _____
3. Power loss from friction of generator _____
4. Power loss from transformer heat _____
5. Power loss from faulty insulators _____
6. Power loss from bad splices _____
7. Power loss from transmission lines _____
8. Power loss from storm damage _____
9. Power loss from short circuits _____

TOTAL POWER LOSS _____

Student Data Sheet 

Activity #7 - Heat - The Thief of Power (continued)

Percentage of fuel energy which is available for use _____
(Subtract total Power Loss from 100%)

Activity #8 - Light Power

1. Fluorescent light bulbs:
   A. Temperature _____ °
   B. Light meter reading _____ foot candles
2. Incandescent bulbs:
   A. Temperature _____ °
   B. Light meter reading _____ foot candles

PART III POLLUTION

Activity #9 - Clean or Dirty

Cleanest _____

Dirty _____

Dirtiest _____

PART IV ALTERNATE SOURCES

Activity #10 - Sun Power

1. Cost $_____
2. Water temperature:
   Beaker #1 _____ °
   Beaker #2 _____ °

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ENERGY IQ QUIZ NAME _____

As you probably know, the world is facing an energy shortage which will grow to more serious proportions as energy supplies dwindle and population increases. You are probably also aware that we, in the United States of America, with 5.5% of the world's population, use 66% of the total energy supplied in the world. We are an energy consuming people, somewhat beyond our reserves and capacity to produce. We may go a long way in extending our natural reserves of fuel by making intelligent choices on everyday decisions which involve energy use. This Energy Seminar will hopefully help you on the way to make better decisions.

Below is an Energy IQ Quiz based in part on the data you have collected. Mark your answer True or False (T or F). After you have answered the questions, check them with the answer sheet.

19 - 20 correct - You have good attitudes and understanding on energy use.

17 - 18 correct - You are headed in the right direction.

13 - 16 correct - You have some knowledge of the energy problem but you need more study and better decisions.

9 - 12 correct - With your attitudes and knowledge, our energy supplies will be used up before alternative sources can be developed.

1. A small amount of home insulation is better than none. _____
2. Three inches of fiberglass insulation is more effective than three inches of styrofoam. _____
3. Black shingles are better because they absorb more of the sun's heat and, therefore, keep your house warmer. _____
4. It is easier to cool a house with white shingles. _____
5. One way to save natural gas would be to shut off all pilot lights on the stove and light the burners with matches. _____
6. Keeping the thermostat set lower doesn't really save enough natural gas to be important. _____

ENERGY IQ QUIZ (cont'd) PAGE 2

7. A furnace with dirty filters provides less heat than one with clean filters. _____

8. Storage batteries are a convenient way to provide large amounts of electricity. _____

9. A hydro-electric power plant is more efficient than a steam generation plant. _____

10. It would be well to spend much time and money to learn how to make generating plants more efficient. _____

11. Storm damage to wires and poles account for a major loss of electrical power. _____.

12. Fluorescent light bulbs give more light than do incandescent light bulbs. _____

13. If you were going to heat your house with light bulbs, it would be best to use fluorescent bulbs. _____

14. Coal or wood appear to be the cleanest fuels we can use today. _____

15. Solar (sun) energy is not used much today because it is in short supply. _____

16. Solar energy is an extremely dirty source of power. _____

17. Electricity produced by atomic energy is our best new source of power. _____

18. Atomic powered generators can be hazardous to your health. _____

19. The gas and oil companies are trying to trick us into paying higher prices by saying there is a gas and oil shortage. _____

20. If every person in the U.S. saved one penny's worth of energy each day, it would amount to $766,000,000 in savings each year. _____.

REGIONAL ENVIRONMENTAL EDUCATION BOARD and QUARRY HILL NATURE CENTER

ENERGY SEMINAR
Data Sheet for Teachers

1. TRUE - Anything which will keep heat in or out, be it a sheet of newspaper or 6 inches of fiberglass, will effect an energy savings.

2. FALSE - As a general rule, one inch of styrofoam is as effective as 3 inches of fiberglass.

3. FALSE - But be prepared for an argument. White shingles provide a cooler attic in summer and, therefore, makes the house more comfortable and/or reduces air-conditioning energy consumption. White shingles in winter likewise cause a cooler attic and, therefore, reduce the snow melt and the snow layer on the roof acts as an insulation itself. One might also suggest that black shingles would make the attic warmer in winter and, therefore, reduce the heating necessary. If an attic is insulated properly (6-10 inches), it doesn't make any difference what color the shingles are.

4. TRUE - See above.

5. TRUE - Over 50% of the domestic natural gas supply goes to feed pilot lights in stoves, ovens, furnaces and water heaters.

6. FALSE - If the calculations are made in Activity #3, you will see that 2 million cu. ft. of gas would be saved each day. In Yourtown alone that change in thermostat setting would save consumers over $400,000 each year

7. TRUE - As shown by the thermometer readings in Activity #4, the dirty filter furnace has more heat going up the chimney.

8. FALSE - Their bulk and weight make them inconvenient for furnishing large amounts of electricity.

9. TRUE - Mainly because there is no fuel being burned in a hydroelectric plant. The sun has furnished the energy to transport the water uphill (water cycle) so that it can be used to produce power.

10. TRUE - A modern steam generating plant is only 33% efficient. The other 66% of the potential energy of the fuel is lost as heat.

11. FALSE - Storm damage accounts for only 1/2 of 1% of electrical loss.

12. TRUE - As evidenced by light meter readings in Activity #8.

13. FALSE - Fluorescent bulbs are cooler than incandescent bulbs.

14. FALSE - Natural gas is cleaner than both coal and wood.

15. FALSE - It is the ultimate source of energy, free and abundant. We need only to learn to convert it cheaply into large quantities of electricity.

16. FALSE - Solar energy is absolutely pure.

17. TRUE - You may get an argument on this also. Although fossil fuel plants are still being constructed, the new source is nuclear plants which are increasing in number.

18. TRUE - The possibility of radiation is very slight but accidents continue to happen.

19. FALSE - There really is a fuel shortage but this question might provoke some discussion.

20. TRUE - Derived by multiplying number of people (210,000,000) by 365 days and mark off 2 decimal places.